index itself, with a list of abbreviations, consisting of twenty pages closely filled in with places in three columns. The colouring of the maps is excellent, and it is obvious that no attempt has been spared to make the book as complete as possible in every way. A. L.

The Young Collector's Hand-book of Ants, Bees, Dragon-Flies, Earwigs, Crickets, and Flies. By W. Harcourt Bath. (London: Swan Sonnenschein, 1888.)

ANY boy who may wish to form a collection of insects will find in this little hand-book all the information he will be likely to need at first for his guidance. The author does not pretend to go deeply into the subject, but he has brought together a sufficient number of facts to show beginners that the study of entomology will well reward any labour that may be devoted to it. His explanations are simple and clear, and the value of the manual is much increased by a large number of good illustrations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*

An Earthquake in England.

AS no account has been given in NATURE of a recent earthquake, perhaps room may be found for the following. I was standing near my garden door at 8.20 a.m. on Sunday, November 20, when the quiet was suddenly broken by a heavy smothered crash, followed by reverberations as in a clap of thunder of rather short duration. I felt no shaking of the ground, but many persons here felt it, and the shaking is stated to have been very marked near Dagnall, between here and Hemel Hempstead. The sound was like the falling in of an immense mass of rock—followed by echoes—in a cavern.

Some persons say they heard a second, but much less loud, crash later in the morning, but this was not heard by me.

At Ampthill, near Bedford, persons left the town to meet the first train from London to inquire of the passengers as to a possible explosion having occurred in London.

The crash was heard in Bucks, Beds, Herts, Suffolk, Essex, Cambridge, and possibly in other counties. I have seen reports from Newmarket, Hitchin, Cambridge, Wimpole, Heydon, Royston, and Saffron Walden, in addition to accounts from many positions close to this place.

It is curious that Stow records, under A.D. 1250, the thirty-fourth year of the reign of Henry III.:—"Upon St. Lucie's Day, there was a great earthquake in this town (St. Albans) and the parts thereabouts, with a noise underground as tho' it thundered, which was the more strange for that the ground is chalky and sound, nor hollow or loose as those are where earthquakes often happen; and this noise did so fright the daws, rooks, and other birds which sat upon houses or trees, that they flew to and fro, as if they had been frighted by a gosshawk." WORTHINGTON G. SMITH.

Dunstable.

On the Constant P in Observations of Terrestrial Magnetism.

THE formula for P given by Mr. Rücker (NATURE, vol. xxxvi. p. 508) has evidently been obtained by expanding the usual expression rigorously to terms of the second order; but as the usual expression differs from Gauss's theory by terms of the second order, Mr. Rücker's expansion is necessarily inexact to the same extent, and in fact his second order term has no existence in Gauss's theory.

Going only to terms involving r^{-5}, Gauss's equations may be written—

$$f(u) = \mathrm{L}r^{-3} + \mathrm{L}^1 r^{-5} \quad \dots\dots \quad (1)$$

$$f(u_1) = \mathrm{L}r_1^{-3} + \mathrm{L}^1 r_1^{-5} \quad \dots\dots \quad (2)$$

$$\frac{m}{\mathrm{H}} = \tfrac{1}{2}\mathrm{L}\left(1 + \frac{\mathrm{S}}{\mathrm{F}}\right) \quad \dots\dots \quad (3)$$

where $f(u)$ signifies either sin u or tan u according to the form of instrument employed.

By putting

$$\mathrm{A} = \tfrac{1}{2}r^3 f(u) \quad \dots\dots\dots \quad (4)$$

$$\mathrm{A}_1 = \tfrac{1}{2}r_1^3 f(u_1). \quad \dots\dots\dots \quad (5)$$

$$\mathrm{B} = \frac{r_1^2 r^2}{r_1^2 - r^2} \quad \dots\dots\dots \quad (6)$$

we find from (1) and (2) respectively

$$\tfrac{1}{2}\mathrm{L} = \mathrm{A}\left\{1 - \mathrm{B}\left(\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}}\right)r^{-2}\right\} = \mathrm{A}\left(1 - \mathrm{P}r^{-2}\right). \quad (7)$$

$$\tfrac{1}{2}\mathrm{L} = \mathrm{A}_1\left\{1 - \mathrm{B}\left(\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}_1}\right)r_1^{-2}\right\} = \mathrm{A}_1\left(1 - \mathrm{P}_1 r_1^{-2}\right) \quad (8)$$

Whence, by inspection,

$$\mathrm{P} = \mathrm{B}\left(\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}}\right) \quad \dots\dots\dots\dots \quad (9)$$

$$\mathrm{P}_1 = \mathrm{B}\left(\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}_1}\right). \quad \dots\dots\dots\dots \quad (10)$$

To find ½L we may use either (4) and (9), or (5) and (10); and in either case the result will be as accurate as our fundamental expressions.

Expanding (10) to terms of the second order,

$$\mathrm{P}_1 = \mathrm{B}\left(\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}}\right) + \mathrm{B}\left(\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}}\right)^2 \quad \dots \quad (11)$$

and therefore the mean of (9) and (10) is

$$\mathrm{P}_0 = \mathrm{B}\left\{\left(\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}}\right) + \frac{1}{2}\left(\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}}\right)^2\right\} \quad . \quad (12)$$

whence, by putting

$$\mathrm{C} = \log \mathrm{A} - \log \mathrm{A}_1$$

and remembering that

$$\frac{\mathrm{A} - \mathrm{A}_1}{\mathrm{A}} = \frac{\mathrm{C}}{\mathrm{M}} - \frac{\mathrm{C}^2}{2\mathrm{M}^2} + \frac{\mathrm{C}^3}{3\mathrm{M}^3}, \text{ \&c.} \quad \dots \quad (13)$$

in which M is the modulus of the common system of logarithms, we have to terms of the second order—

$$\mathrm{P}_0 = \frac{r_1^2 r^2}{r_1^2 - r^2}\left\{\frac{\log \mathrm{A} - \log \mathrm{A}_1}{\mathrm{M}}\right\} \quad \dots \quad (14)$$

Equation (9) is what I gave in my letter on p. 366 of the last volume of NATURE, where I was careful to say that it was derived from Gauss's original equations. When properly used it is as accurate as equations (1) and (2). Equation (14) was given by Mr. Ellis in his letter on p. 436. It is slightly easier to compute than (9), and differs from that expression by a term of the second order which is less than the accidental error of observation. The second order term added by Mr. Rücker renders his expression less accurate than either (9) or (14), if Gauss's theory is accepted as correct. WM. HARKNESS.

Washington, D.C., November 4.

I THINK that on reconsideration Prof. Harkness will admit that it is not I who have fallen into error. If only two observations are made, equations (7) and (8) are identical, and there is no need for the introduction of P_0. In like manner if numerous measurements were available in which the error of observation was *nil*, any pair would give the same value of L, and P_0 would again be unnecessary. If, however, the equations are affected by errors of observation, and it be agreed that in combining them we may replace the P's by a single quantity, P_0, it must not be arbitrarily defined. Prof. Harkness assumes that in the case of two observations it must be the mean of P and P_1, but he gives no reasons, and he does not state what value he would adopt if

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the measurements were numerous. The proper course is to determine it by the method of least squares.

Writing f for $f(u)$ and omitting $1 + \frac{S}{F}$, (3) may by the aid of (7) be written in the form—

$$\frac{1}{f} = \frac{H}{2m}(r^3 - P_0 r).$$

This is exactly analogous to the equations used by Maxwell in the determination of the quantity A_2, which in his notation and method of development corresponds to P_0 ("Electricity and Magnetism," second edition, vol. ii. p. 100). It is unnecessary to occupy the pages of NATURE with a reproduction *mutatis mutandis* of his formulæ. We can get, as he does, a general expression for P_0 when we have n equations at our disposal, and when $n = 2$ this reduces (in the notation of Prof. Harkness) to—

$$(\alpha) \qquad P_0 = (A - A_1)/(A/r^2 - A_1/r_1^2).$$

If then in a magnetic survey observations are made at two distances at a number of stations, we should take as the final value of P_0 the mean of the most probable values found at each station. As this would be unduly laborious, we approximate. By an obvious transformation (α) becomes—

$$\log\left(1 - \frac{P_0}{r_1^2}\right) - \log\left(1 - \frac{P_0}{r^2}\right) = \log A - \log A_1$$

$$\therefore P_0(r^{-2} - r_1^{-2}) + \frac{P_0^2}{2}(r^{-4} - r_1^{-4}) + \&c. = \frac{\log A - \log A_1}{M}.$$

Thus to a first approximation—

$$(\beta) \qquad P_0 = \frac{r^2 r_1^2}{r_1^2 - r^2}\,\frac{\log A - \log A_1}{M}.$$

And if we substitute this value in the small term—

$$(\gamma) \qquad P_0 = \frac{r^2 r_1^2}{r_1^2 - r^2}\,\frac{\log A - \log A_1}{M} - \frac{r_1^2 r^2}{2}\,\frac{r_1^2 + r^2}{(r_1^2 - r^2)^2}\left(\frac{\log A - \log A_1{}^2}{M}\right).$$

This is the expression I gave. The effect of the small term in (γ) is, as I pointed out, less than the error of experiment, but it diminishes the difference between the rigorous and approximate values of P_0 given in (α) and (β), and it is useful in indicating the magnitude of the difference between them.

Fortunately all methods lead to (β) as a first approximation which we are agreed is close enough for practical purposes. If, however, we regard the observations as fallible, (α) gives a better value of P_0 than (14), and equation (γ) gives a closer approximation to it than (β) does. ARTHUR W. RÜCKER.

Science Schools, South Kensington, November 24.

P.S.—It may be well to add that, although the formula for A_2 is correctly given by Maxwell in line 17, p. 101, the value of A_2 deduced below is incorrect, being really that of $2MA_2/H$. There is another misprint immediately below, δD being substituted for δQ in the second edition.

Instability of Freshly Magnetized Needles.

I SHOULD like to be permitted to support Prof. Rücker in his reply to Prof. Nipher (NATURE, vol. xxxvii. p. 77), with a few remarks on the subject of observations of magnetic dip.

The question of the degree of accuracy of dip observations is one that has been repeatedly raised and discussed. In 1864 in his report to the Board of Visitors, the Astronomer-Royal, Sir G. B. Airy, referred to the matter, and a correspondance between him and the Chairman of the Kew Committee (Mr. L. P. Gassiot) ensued, which is printed *in extenso* in the Report of the British Association for 1864, pp. xxxiv.-xlvii.

In reply to an inquiry by Mr. Gassiot as to whether the paragraph in the Report was intended to apply to dip observations made at the Kew Observatory, Sir G. B. Airy quoted the following statement by Sir E. Sabine :—"The probable error of a *single observation of the dip* with reliable instruments of easy procurement is known to be ± 1'·5. It has been shown to be so by a series of 282 observations made at Kew, employing twelve circles and twenty-four needles, all of the pattern which has been in use at Kew for several years past. The observations were made by seven different observers; the results are published in the Proceedings of the Royal Society, March 1861, vol. xi. p. 156, from entries in the Kew Observatory books, not a single observation having been omitted. The probable error ± 1'·5 may be regarded as including *constant* errors, considering the number of different circles and needles which were employed, as well as the peculiarities of different observers, of whom there were seven" (the italics are General Sabine's). The Astronomer-Royal then concluded by stating "these are the probable errors which I cannot accept as accurate."

As a result of the correspondence, a series of observations was made at both the Greenwich and Kew Observatories by the observers of both institutions, with the same Kew pattern instruments, and then Sir G. Airy wrote, in a letter dated November 15, as follows: "As regards the results of observations, those made with the Kew instruments are consistent to a degree which I never saw before; and the results for dip obtainable with the Kew dip instruments are undoubtedly more consistent and more certain than I had supposed them to be."

A similar inquiry was set on foot by Dr. H. Wild, of St. Petersburg, and in 1886 we made a large number of observations with different needles for him, the resulting error of an observation being in this case ± 1'·3. The most severe test, so far as we are aware, which has been applied to dip observation, is that recently described by M. E. Leyst, of St. Petersburg, in a quarto volume of 133 pages, published in the *Repertorium für Meteorologie*, entitled "Untersuchung über Nadel Inclinatorien."

The author discusses some 6576 observations of dip made with different instruments and needles, and determines their probable errors, which he always find small, so much so that he deduces the corrections to hundredths of a minute of arc. To quote particular cases, he determines from thirty series of comparisons between observations and the simultaneous readings of the magnetographs and the induction inclinometer, that the difference amounts to only 1'·06; and again, by comparing at Pawlowsk the fifteen needles of the three dip instruments of the Pawlowsk, Irkutsk, and Ekaterinburg Observatories (all of English make, obtained through this Observatory), he finds their mean correction to be nil.

Judging from the experience gained at Kew by the examination of probably 150 circles and 500 needles by various makers and different observers, I can thoroughly indorse Prof. Rücker's opinion that Prof. Nipher's instruments are scarcely capable of satisfying modern requirements as to accuracy, and are such that were they submitted to us for examination they would be promptly returned to their makers for adjustment.

G. M. WHIPPLE.

Kew Observatory, November 26.

Gore's Railway.

AS I have had several letters concerning my use of Dr. Gore's arrangement, depicted on p. 107 of your last week's issue, perhaps I may as well say that I am aware it is commonly regarded as a Trevelyan rocker, and that I doubt not its function in that connection. This point of view is so familiar to every one, through Tyndall's "Heat," that I thought it unnecessary to mention it. But I have occasionally heard the motion of the ball attributed to the electro-magnetic action of the current on itself—which is impossible—and I thought it useful to point out that it could nevertheless be used as an illustration of electro-magnetic force, provided a vertical magnetic field is applied as well as a current. I should imagine the earth not too weak to have an effect under favourable conditions; but of course such an effect would be strictly definite in direction, and reversible.

OLIVER J. LODGE.

The Highclere Bagshots.

THE notice in NATURE for December 1 (p. 104), by my friend Mr. R. S. Herries, of casts of shells in the Bagshot Beds at Highclere tends strongly to confirm the results of my own work in that district. On the strength of physical and stratigraphical evidence, I have shown the development in that neighbourhood of *all the three stages* of the Bagshot formation

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